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Swiss Accident Investigation Board SAIB

Aviation Division

Final Report No. 2156 of the Swiss Accident Investigation Board SAIB

concerning the accident involving the C525 aircraft, registration HB-VOV

on 16 February 2011

at Grenchen regional airport (LSZG)

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Ursachen

Der Unfall ist auf eine Kollision mit Hindernissen nach dem Pistenende zurückzuführen, weil das Flugzeug während des Startlaufs die zu erwartende Beschleunigung nicht erreichte und dieser trotzdem fortgesetzt wurde.

Folgende Faktoren wurden als ursächlich ermittelt:

- Eine reduzierte Beschleunigung des Flugzeuges während des Starts aufgrund der gesetzten Feststellbremse.
- Der fehlende Entschluss der Besatzung, auf die reduzierte Beschleunigung mit einem Startabbruch zu reagieren.

Zum Unfall beigetragen hat, dass das Flugzeug keine Warnvorrichtung aufwies, welche beim Einleiten des Startlaufs auf eine gesetzte Feststellbremse hinweist.

General information on this report

This report contains the Swiss Accident Investigation Board's (SAIB) conclusions on the circumstances and causes of the accident which is the subject of the investigation.

In accordance with Art 3.1 of the 10th edition, applicable from 18 November 2010, of Annex 13 to the Convention on International Civil Aviation of 7 December 1944 and Article 24 of the Federal Air Navigation Act, the sole purpose of the investigation of an aircraft accident or serious incident is to prevent accidents or serious incidents. The legal assessment of accident/incident causes and circumstances is expressly no concern of the accident investigation. It is therefore not the purpose of this investigation to determine blame or clarify questions of liability.

If this report is used for purposes other than accident prevention, due consideration shall be given to this circumstance.

The definitive version of this report is the original in the German language.

All times in this report, unless otherwise indicated, are stated in local time (LT). At the time of the accident, Central European Time (CET) applied as local time in Switzerland. The relation between LT, CET and coordinated universal time (UTC) is:
LT = CET = UTC + 1 hour.

Final Report

Aircraft type	Cessna Citation C525	Registration HB-VOV
Operator	Swiss Private Aviation Ltd., GAC, 8058 Zurich airport	
Owner	Mathys Aviation Ltd., Flughafenstrasse 117, 2540 Grenchen, Switzerland	

Commander	Swiss citizen, born 1944			
Licence	Airline transport pilot licence aeroplane (ATPL(A)) according to Joint Aviation Requirements (JAR), first issued by the Federal Office of Civil Aviation (FOCA) on 14 July 1980			
Essential ratings	Type rating C525 with instrument flying rating as pilot in command, valid till 25 March 2011.			
Medical fitness certificate	Class 1 / 2, restrictions: VDL (shall wear corrective lenses and carry a spare set of spectacles), valid from 29 November 2010 till 15 June 2011			
Flying hours	**total**	14 421:30 hours	**during the last 90 days**	19:44 hours
	on the accident type	107:24 hours	**during the last 90 days**	15:05 hours

Co-pilot	Swiss citizen, born 1980			
Licence	Commercial pilot licence aeroplane (CPL(A)) according to Joint Aviation Requirements (JAR), first issued by the Federal Office of Civil Aviation (FOCA) on 27 June 2005			
Essential ratings	Type rating C525 with instrument flying rating as pilot in command, valid till 25 June 2011.			
Medical fitness certificate	Class 1 / 2, no restrictions, valid from 23 August 2010 to 8 September 2011			
Flying hours	**total**	1705:22 hours	**during the last 90 days**	16:25 hours
	on the accident type	178:00 hours	**during the last 90 days**	10:42 hours

Location	Regional airport Grenchen (LSZG)		
Coordinates	-	**Elevation**	430 m AMSL
Date and time	16 February 2011, 08:53 LT		

Type of operation	IFR private
Flight phase	Take-off
Type of accident	Collision with obstacle

Injuries to persons

Injuries	Crew	Passengers	Total number of occupants	Others
Fatal	0	0	0	0
Serious	0	0	0	0
Minor	0	0	0	0
None	2	0	2	Not applicable
Total	2	0	2	0

Damage to aircraft Badly damaged

Other damage End-of-runway light, minor damage to grassland

1 Factual information

1.1 Pre-history and history of the flight

1.1.1 General

For the following description of the pre-history and history of the flight, the recordings of the radiotelephony communication, radar data and the statements of the crew members and air traffic controllers were used. The recordings of the installed enhanced ground proximity warning system (EGPWS) and of the engine data were used for purposes of comparison.

The co-pilot was pilot flying (PF) and the commander was pilot not flying (PNF). It was a ferry flight under instrument flight rules (IFR) from Grenchen regional airport (LSZG) to the scheduled destination of Newquay Cornwall (EGHQ).

1.1.2 Pre-history

The ferry flight of the Citation C525 aircraft, registration HB-VOV, was a private flight and was made under the air operator certificate (AOC) and in accordance with the standard operating procedures (SOP) of Swiss Private Aviation (cf. chapter 1.4.1).

Flight preparation was carried out using a Mathys Aviation (MAv) flight preparation checklist. As contractually regulated, the crew had at their disposal the preflight planning system (PPS) as a tool for flight preparation.

When he came on duty, the commander ascertained that all points of the flight preparation checklist had been completed correctly. This included, among other things, in addition to the calculation of the mass and balance, the determination of the take-off performance, using the "Performance Guru" software. The abovementioned calculations were performed on 15 February 2011 and the corresponding documents printed out (cf. chapter 1.2.4).

The crew then jointly studied the weather and the NOTAM for the forthcoming flight. Subsequently, the copilot completed cockpit preparation and took care of the catering, while the commander carried out the outside check of the aircraft. The aircraft was then towed by the crew with the aid of a tractor from the hangar to the refuelling point and refuelled with 590 litres of Jet A1. Therefore there was an actual block fuel of 2290 lb on board, corresponding to a maximum endurance of 2 hours 44 minutes. Then the aircraft was towed to stand "white alpha" and the parking brake was set.

1.1.3 History of the flight

On 16 February 2011 aircraft HB-VOV left stand "white alpha" at 08:48 LT. The crew had previously received the necessary clearance to take off from runway 07 after a request to Grenchen aerodrome control (tower). The de-icing system was switched on from the outset in view of the prevailing conditions. The taxi checklist was completed on the short route to the runway 07 holding position via taxiway WHISKEY. This included, among other things, testing the functionality of the brakes, which was carried out by both crew members. No anomalies were found.

At approximately the same time, the Grenchen aerodrome control air traffic control officer (ATCO) arranged for a runway inspection, as visibility did not allow a view from the tower to the end of runway 07. As the ATCO stated, this procedure is applied to ensure that there is nothing on the runway.

After receiving clearance at 08:51 LT, the commander steered the aircraft onto runway 07 and initially turned west, in order to have the maximum runway length available for the subsequent take-off (backtrack). After a further 180 degree

clockwise turn, HB-VOV was positioned just north of the runway centerline, pointing to the east. To take advantage of the available runway length, the commander, according to his own statements, did not manoeuvre the aircraft precisely onto the runway centerline.

The ATCO observed HB-VOV taxiing onto the runway and instructed the crew to hold on the runway, as a runway inspection was still in progress. In view of the expected delay, the commander then set the parking brake.

At 08:53:43 LT, the crew of HB-VOV received take-off clearance: *"Hotel Oscar Victor, wind zero six zero degrees six knots, runway zero seven, cleared for take-off"*. The commander then switched on the pitot heater and landing lights, pushed the thrust levers forward and handed control over to the copilot. He instructed the copilot, in view of the reduced visibility, to carry out a so-called standing take-off. At a power setting with a low-pressure compressor speed N1 of approximately 90% of the rated speed the copilot took his feet off the brake pedals, set take-off thrust and steered the aircraft on the runway centerline. The set take-off thrust was checked by both crew members.

The ATCO watched the HB-VOV take-off roll. At the position of taxiway NOVEMBER she believed she noticed slower acceleration than usual. In her experience, it was common for HB-VOV to lift off at approximately the runway 25 touchdown point for single-engine aircraft with fixed landing gear (cf. Annex 1). At this point however, HB-VOV was still on the ground, according to her statement.

After checking the take-off thrust and the speed indications at the beginning of the take-off roll, the commander had the impression that the aircraft's acceleration was lower than usual. HB-VOV attained a speed of 80 kt before taxiway ECHO 1 (cf. Annex 1), i.e. rather late, but still within a framework which seemed acceptable to the commander. On reaching rotation speed (V_R), in the co-pilot's estimation approximately 250 m before the end of the runway, the commander called out *"rotate"*, whereupon the copilot pulled on the control column. Both crew members immediately noticed that the nose of the aircraft was not lifting. After a repeated callout by the commander, he too pulled on the control column. On overshooting the end of the runway, the right main landing gear of HB-VOV struck a "end-of-runway" light, which was perceived by the crew as a distinctly noticeable impact. On the transition from the runway to the grass, the copilot, according to his statement, had the feeling that it was no longer possible to continue the take-off and briefly reduced power. But at approximately the same time, the copilot noted that HB-VOV had already lifted off and applied full power again. At the same time, he asked the commander whether the take-off process should continue. The latter answered the copilot's question in the affirmative, with the consideration that they would perhaps still have a chance to get the aircraft into the air. The events from overshooting the end of the runway to lift-off of HB-VOV, after a roll of more than 100 metres in the adjacent meadow, occurred within a few seconds. In the process the aircraft crossed a small stream bed running perpendicular to the runway.

Figure 1: View in the direction of departure at the end of runway 07. In the foreground on the right: the end-of-runway light which was struck (circled in orange).

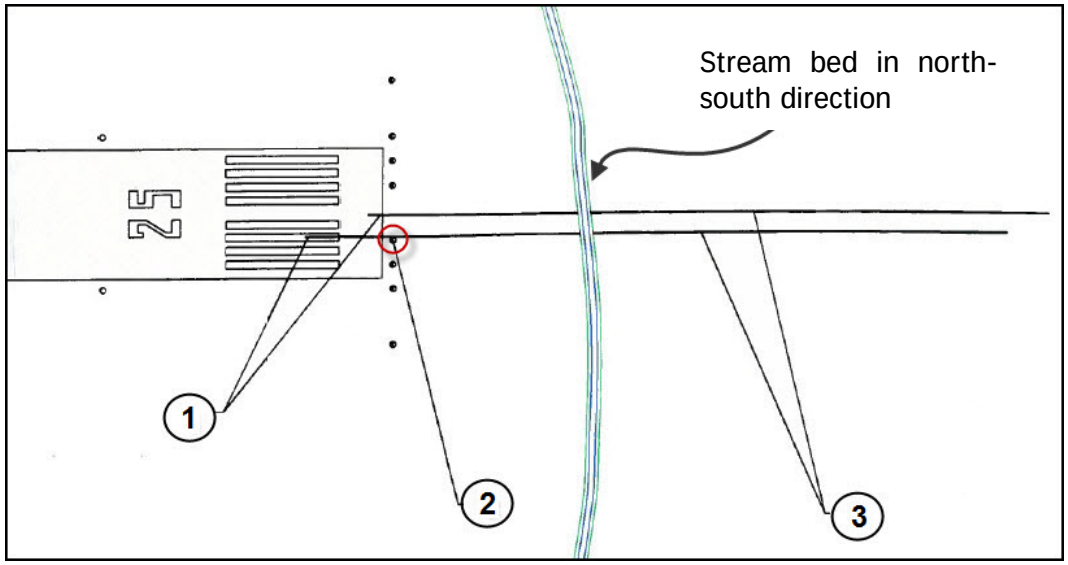


Figure 2: Adjacent meadow beyond the end of runway 07 at Grenchen regional airport. **1:** Traces of blocked brakes shortly before the end of runway 07 with a length of 2.6 m and 13.6 m respectively; **2**: damaged end-of-runway light; **3**: tracks in the adjacent meadow with a total length of approximately 118 m and 110 m respectively. After almost 40 metres, a small stream bed runs from north to south.

The ATCO, who was monitoring the take-off roll, heard a click on the radio frequency as HB-VOV approached the end of the runway. She took up the binoculars and was still able to see the aircraft's strobe lights. Then she made sure on the radar screen that HB-VOV had actually lifted off.

Once the aircraft had attained the normal attitude for a climb at the appropriate take-off safety speed V_2, the commander reduced power to maximum continuous thrust (MCT*)* and retracted the flaps. Then the crew realised that the parking brake was still set. The commander retracted the landing gear and detected that the red warning light did not go out. He instructed the copilot to keep the speed low and extended the gear again. All three landing gear indicators indicated green. At an altitude of approximately 3500 ft AMSL, HB-VOV was transferred to Berne arrival air traffic control. As part of the climb check, the de-icing system was switched off again.

The crew subsequently decided to make an alternate landing at Zurich airport. The crew did not declare an emergency and did not apply for landing priority. According to the landing gear indicators in the cockpit, the crew assumed that the landing gear was extended and locked. For this reason they did not make a low pass at Zurich airport for an external visual check of the landing gear.

After the approach and landing, HB-VOV exited runway 14 at the end via taxiway HOTEL 3. The crew then waived a visual check and taxied the aircraft directly to the stand on the apron near the General Aviation Centre (GAC).

As a result of the collision of the right main landing gear of HB-VOV with the end-of-runway light and the subsequent crossing of the stream bed, structural damage was found in the area of the nose gear and main gear, as well as to both rear wing spars. Also, a certain asymmetry was ascertained in the dimensions of the aircraft.

The two pilots were uninjured in the accident.

1.2 Aircraft information

1.2.1 General

Registration	HB-VOV
Aircraft type	CE 525 CJ1+
Characteristics	Seven-seater business aircraft with twin jet engines
Manufacturer	Cessna Aircraft Company, Wichita, USA
Year of manufacture	2008
Serial number	525-0665
Engine type	Williams International FJ44-1AP
Max. permitted take-off mass	10 700 lb (4853 kg)
Max. permitted landing mass	9900 lb (4491 kg)
Mass and centre of gravity	The mass and centre of gravity of the aircraft were within the permitted limits.
Technical limitations	None
Aircraft category	B
Minimum visibility for take-off	150 m

Flying with gear extended	No information from the manufacturer concerning increased consumption.
Licence	The aircraft is licensed for single pilot operation (single pilot aircraft – SPA). Under Swiss Private Aviation the C525 aircraft was operated with a two-person crew (multi pilot aircraft – MPA).

1.2.2 Information on the parking brake

In order to set the parking brake, the activation lever for the parking brake must be pulled with the brake pedals depressed. In the process, in the brake units of the main landing gear the prevailing hydraulic pressure is maintained by means of a corresponding parking brake control valve. In this context, the pressure level of the sealed hydraulic fluid is dependent on the pressure applied by the pilot on the brake pedals. To release the parking brake, the brake pedals must again be depressed with the feet and at the same time the parking brake activation lever must be pushed. It is not sufficient to briefly increase the pressure on the brake pedals and then reduce it. In the cockpit of the CE 525 CJ1+ there is neither an indication as to whether the parking brake is set nor a corresponding alarm signal when take-off power is applied if the parking brake is not released. Only later models of the C525 Series have an installed parking brake indicator.

For this category of aircraft, installation of a corresponding warning system is not necessary for certification.

Figure 3: The actuating lever for the parking brake is located left of the commander's control column (circled in orange).

Figure 4: The actuating lever of the parking brake is concealed by the commander's left knee.

This fact was known to the crew. In addition, the crew stated that the parking brake was working normally up to the time of the accident.

A check of the functioning of the braking system after the accident revealed no abnormalities.

The commander also stated that the actuating lever of the parking brake was not easy to identify from his seat (cf. Figure 3 and Figure 4). To see this, he would have had to bend forward or move his left knee to the right towards the control column.

The copilot stated the actuating lever of the parking brake was not easy to identify from his seat; he would have had to bend forward and turn his head to the left.

After leaving the stand, during normal operation the parking brake is no longer mentioned as a checklist point in the Swiss Private Aviation normal checklist.

1.2.3 Similar incidents

The manufacturer of the aircraft stated that in the years from 1997 to 2011, to its knowledge a total of eleven incidents occurred involving take-offs with the parking brake set.

1.2.4 Information on calculation of take-off performance

The necessary take-off distance (runway length) for a specific take-off mass (aircraft mass) is dependent on the aerodrome's elevation above mean sea level (AMSL), the outside temperature, the atmospheric pressure, the wind, and the runway surface (dry, wet or contaminated).

For operation, the following speeds are significant:

- Decision speed (V_1)
  If one engine fails at this speed, the aircraft is able either to continue the take-off with a safe climb or abort the take-off and come to a standstill on the runway.
- Rotation speed (V_R)
  This is the speed at which rotation is started.
- Take-off safety speed (V_2)
  This speed guarantees a safe climb with one engine failed at V_1. It is 20% above the stall speed.

1.2.4.1 Calculation according to Performance Guru

The day before, the crew carried out the required calculation of mass and centre of gravity, as well as the take-off performance using the "Performance Guru" software (version 2.0). The latter in particular provides information to the crew on the maximum possible take-off mass and the climbing procedure in the event of an engine failure. These details were always printed out and kept for comparison with the aircraft-side performance calculation (cf. chapter 1.2.4.2)

The basis of the calculation for the take-off on runway 07, with a take-off run available (TORA) of 3281 ft (1000 m)[1] read as follows:

Aerodrome elevation:	1411 ft AMSL
Runway surface:	Dry
Actual take-off mass (ATOM)	9695 lb (approx. 4398 kg)
Outside air temperature:	6 °C
Atmospheric pressure QNH:	1001 hPa
Wind speed:	No wind
Position of flaps:	15 degrees
De-icing system:	Off

[1] The TORA cited in the Swiss aeronautical information publication (AIP) for runway 07 is 980 m.

The values of the critical speeds critical for take-off on runway 07 were output by the software as follows:

- Decision speed V_1 = 95 kt
- Rotation speed V_R = 99 kt
- Take-off safety speed V_2 = 106 kt

The maximum possible take-off mass (MTOM) given the available take-off performance was shown as 10 520 lb (approx. 4772 kg).

With an identical basis for calculation, but with the de-icing system switched on, the result is an MTOM of 10 246 lb (approx. 4651 kg).

However, other data, in particular the available distance after an aborted take-off compared to the total accelerate stop distance required (ASDR), is not provided by the software.

Nor can corresponding information from the manufacturer be consulted in the aircraft flight manual (AFM).

1.2.4.2 Calculation using the flight management system

The actual performance calculation relevant to the take-off was made in the flight management system (FMS) for dry and wet runways. After the take-off runway, take-off mass, take-off configuration, wind conditions, outside pressure and temperature have been entered, a take-off field length and critical speeds are calculated, taking obstacles into account. The take-off field length is shown in metres, includes the necessary safety reserves for the take-off and covers the cases of both an engine failure after V_1 and an aborted take-off before V_1. Usually, this calculation is carried out by the PF after starting the engines, but before leaving the stand, on the basis of the current weather conditions.

In the course of the investigation, the calculation of the take-off performance was performed again using the FMS of the aircraft involved in the accident, HB-VOV, taking into account the following details.

Aerodrome elevation:	1411 ft AMSL
Runway surface:	Dry
Actual take-off mass (ATOM)	9695 lb (approx. 4398 kg)
Outside air temperature:	2 °C
Atmospheric pressure QNH:	999 hPa
Wind speed:	No wind
Position of flaps:	15 degrees
De-icing system:	On

The resulting speeds were as follows:

- Decision speed V_1 = 96 kt
- Rotation speed V_R = 99 kt
- Take-off safety speed V_2 = 106 kt

The calculated take-off field length is = 2808 ft (856 m).

1.3 Meteorological information

1.3.1 General

The information in chapter 1.3.2 to 1.3.4 was provided by MeteoSwiss and translated from German.

1.3.2 General meteorological situation

An extensive area of low pressure extended over western and central Europe. With south-westerly winds at high altitudes, humid air was being conveyed towards the south side of the Alps in particular. Over the Swiss Plateau there was extensive cover of fog or high-altitude fog, which only cleared towards mid-day.

1.3.3 Weather report for Grenchen regional airport

In the period from 07:20 UTC to the accident, the following aerodrome routine meteorological report (METAR) were in effect for Grenchen regional airport:

LSZG 160720 07002KT 0200 FG VV002 02/02 Q0999 NOSIG=

LSZG 160750 08006KT 0300 -RA VV002 02/02 Q0999 NOSIG=

In clear text, this means:

On 16 February 2011, shortly before the 07:50 UTC issue time of the aerodrome weather report, the following weather conditions were observed at Grenchen regional airport:

Wind	From 080 degrees at 6 kt
Meteorological visibility	300 m
Weather:	Light rain
Cloud	Vertical visibility 200 ft above ground
Temperature	02 °C
Dewpoint	02 °C
Atmospheric pressure:	999 hPa, pressure reduced to sea level, calculated using the values of the ICAO standard atmosphere
Land weather forecast	In the two hours following the weather observation, no significant changes are expected.

1.3.4 Weather at the site of the accident

On the basis of the information listed, it is possible to conclude that the following weather conditions prevailed at the time and location of the accident:

Cloud:	Vertical visibility 200 ft AGL
Weather:	Fog, light precipitation possible
Visibility	Approximately 300 m
Wind	North-east variable at 5 kt
Temperature	02 °C
Dewpoint	02 °C
Atmospheric pressure	QNH LSZG 0999 hPa, QNH LSZH 0999 hPa, QNH LSGG 0998 hPa
Hazards	Poor visibility conditions due to fog

1.4 Operational aspects

1.4.1 Ownership, operator and operating procedures

The Citation C525 aircraft was the property of Mathys Aviation at the time of the accident. Since 2010, the aircraft had been listed in the air operator certificate (AOC) of Swiss Private Aviation. An aircraft management and charter agreement between the owner and operator regulated the operation of the C525.

In the context of a list of beneficiaries, which was part of this contract in the form of an appendix (Appendix C - Mathys Beneficiaries), private flights were also conducted. The planned flight from Grenchen to Newquay Cornwall was a ferry flight to such a private flight.

All flights were carried out according to standard operating procedures (SOP). In a Swiss Private Aviation internal bulletin, dated 8 January 2010, it was stated that because of the short and narrow runway at Grenchen, all arrivals and departures were allowed to take place only in the context of private flights. This directive refers to the section in the Operating Manual (OM) A, 8.7.11 - Private Flight, in which deviations from the SOP are explicitly stated. Special restrictions were issued for the approach at Grenchen, for example a reduced landing safety factor for landing distance calculations of 1.25. Furthermore the bulletin also states that take-off and landing may be carried out only by the commander.

When Mathys Aviation was operating under the AOC of TAG Aviation, copilots were also permitted to carry out take-offs from Grenchen.

1.4.2 Additional information on the pilots

The crew of HB-VOV was employed by Mathys Aviation. With the entry into the AOC of Swiss Private Aviation, both pilots, after successfully completing an assessment and a so-called change of operator course, were flying on behalf of Swiss Private Aviation. Within this period neither the commander nor the copilot attracted negative attention in any way. Both provided good service during this period and were well qualified.

On the basis of the regulations in effect at the time of the accident, the commander was deployed only on private flights at Swiss Private Aviation because of his age. Nevertheless, he still had to undergo all annual and operationally relevant checks to maintain his licence. He stated that he had made several hundred take-offs from Grenchen on the C525 aircraft.

Before joining Swiss Private Aviation, the copilot had successfully completed training as a commander under TAG Aviation, the former AOC holder for commercial flights. Within the framework of private flights, he was also deployed as PIC at that time. Owing to a lack of total flying hours, however, he was deployed as a copilot in the flight operations of Swiss Private Aviation. He stated that he had made approximately 200 take-offs from Grenchen on the C525 aircraft.

2 Analysis

2.1 Technical aspects

2.1.1 General

There is no evidence of the existence of any technical defects or limitations which could have caused or influenced the accident.

2.1.2 Parking brake

As stated in chapter 1.2.2, the effect of the parking brake is dependent on the pressure of the sealed hydraulic fluid; this in turn is dependent on the force with which the pilot depresses the brake pedals when setting the parking brake. If this pressure is only moderate, it is possible that the aircraft can be kept at a standstill by the parking brake when the engines are at idle. However, if the engine power is increased, the aircraft can start to roll and even take off. According to the manufacturer, several incidents of this type have occurred in the past.

The fact that the visibility of the actuating lever for the parking brake was reportedly difficult for both crew members to see, together with the absence of a warning if a take-off is initiated with the parking brake set, led in the present case to the fact that the set parking brake remained unnoticed during the take-off roll.

In addition, the checklist for the operation of the aircraft does not prescribe a parking brake check at the beginning of the take-off roll.

2.2 Human and operational aspects

2.2.1 Calculation of take-off performance

According to the crew's statement, the de-icing system was switched on from the outset until the climb check was completed. The previous day's calculation of take-off performance using Performance Guru, however, was performed without including the de-icing system. In a comparison of the two results concerning the relevant speeds (V_1, V_R, V_2), no substantial differences can be determined. Also, the maximum take-off mass (MTOM) in the event of an engine failure produces a value only approximately 2.5% lower, due to the loss of performance because of the activated de-icing system. However, in terms of the actual take-off mass (ATOM) of 9695 lb (approx. 4398 kg), which is clearly lower, this error plays a subordinate role.

Neither in the tables on take-off performance from the manufacturer nor in the Performance Guru software is the crew provided with information showing the reserve with which an impending take-off can be carried out. The crew has at its disposal only the information that a take-off is basically possible on a given runway at the specified ATOM. Only a comparison between the specified ATOM and the calculated MTOM allows the crew to draw an indirect conclusion about any existing reserve. However, this cannot be easily expressed in the form of a distance, especially since the MTOM is calculated with reference to a possible engine failure.

From the calculation of the take-off performance using the onboard FMS, the crew is provided with a take-off field length. If this is compared with the available runway length of runway 07 of 980 m published in the AIP, it is apparent that with 124 metres the crew basically had a small safety margin available.

2.2.2 Take-off roll and alternate landing

The crew stated that on taxiing onto the runway they ensured, using backtrack, that they had the maximum runway length available for the subsequent take-off.

For the same reason, in the present case they did not manoeuvre the aircraft exactly onto the runway centerline. This behaviour was safety-conscious and allows the conclusion that the crew were clear, from a large number of take-offs from Grenchen, that on take-off with a C525 on this short runway they had basically only a little reserve available.

From experience, both crew members had a concept of the acceleration behaviour of HB-VOV. They were also acquainted with the area of the runway at which the aircraft would typically reach rotation speed (V_R), i.e. when it would lift off from the runway.

The take-off roll represents a time-critical phase of the flight, during which a comprehensive assessment of the situation is not possible on the basis of the dynamics. For this reason, decision-making criteria and corresponding procedures in the sense of reserved decisions for specific scenarios are defined before take-off. In particular on a take-off on a relatively short runway, preconceived decisions and thus the willingness to abort take-off roll early at the merest hint of a failure or adverse affect is essential. In the present case, both the commander and the copilot sensed a lower than usual acceleration at the beginning of the take-off roll. Obviously the awareness was missing that a lower acceleration can lead to endangerment on the short runway in Grenchen. The crew let it by checking the engine parameters, which were normal and continued the take-off. This behaviour shows that a limited awareness over the total situation existed and at the same time the capability for analysis and for fallback to predetermined pattern of action being necessary in time critical situations was missing.

HB-VOV reached a speed of 80 kt before taxiway ECHO 1 (cf. Annex 1), i.e. somewhat later than usual, as the crew stated. The acceleration was lower than usual as a result of the parking brake being set. Whether take-off abortion to a complete standstill of the aircraft before the end of the runway at this point in time would have been possible, cannot be determined with certainty.

The fact that the nose of the aircraft did not lift at rotation speed (V_R) is attributable to the fact that an additional pitch down moment existed because of the set parking brake.

Only at a lower frictional resistance in the adjacent meadow would the down force on the deflected elevator have been sufficient to lift the nose gear, enabling HB-VOV finally to lift off from the ground.

The commander's decision not to abort the take-off roll on overshooting the end of runway 07 but to continue in the hope that HB-VOV could still lift off was taken intuitively.

Based on the severe damage of the aircraft and the marks at the end of the runway it can be concluded, that the take-off was successful only by chance and could have lead just as well into a catastrophe.

The crew then decided not to continue the flight to the original destination but to divert to Zurich airport with the landing gear extended. This decision was logical, as this would put long runways at the crew's disposal. Even if they had no information on extra consumption from the manufacturer, the crew undoubtedly had sufficient fuel on board to make this flight.

The crew subsequently decided not to declare an emergency on the basis of the landing gear indicators in the cockpit. They also decided not to accept the offered higher landing priority in Zurich. Apparently the crew paid to little attention to the fact that the aircraft got hit while overrunning the runway-end and crossing the adjacent stream bed and thereafter the landing gear could not be retracted.

2.2.3 Operating procedures

In a so-called low-visibility take-off (LVTO), with visibility below 400 m in particular on short and narrow runways, a take-off represents a demanding task for a pilot, regardless of the aircraft type. The fact that in such a situation the crew member with less overall flying experience performs the take-off as PF unnecessarily increases the risk.

On take-off from Grenchen, the commander set the parking brake after reaching the take-off position and after receiving take-off clearance handed over control to the copilot. It seems reasonable to assume that on handing over control to the copilot the commander was no longer aware of the set parking brake. Possibly also the delay due to the runway inspection may have played a part in this.

As the present case shows, the decision ultimately lies with the commander, particularly in time-critical, unclear situations. Regardless of the bulletin dated 8 January 2010, according to which the copilot was no longer authorised to take off from Grenchen as PF, it appears from the safety viewpoint to be appropriate that in this situation the crew member with the greater overall flying experience should perform the take-off as PF. Consequently, the crew's deviation from a safety-related division of work made a significant contribution to the origin of this accident.

3 Conclusions

3.1 Findings

3.1.1 Aircraft

- The aircraft was licensed for IFR and VFR operation.
- The aircraft was licensed for a low-visibility take-off (LVTO) with at least 150 m visibility.
- The mass and centre of gravity of the aircraft were within the permitted limits.
- The aircraft exhibited no technical defects or limitations which may have affected or caused the accident.
- The checklist for the operation of the aircraft does not prescribe a parking brake check at the beginning of the take-off roll.

3.1.2 Crew

- The crew were in possession of the necessary licences for the flight.
- There are no indications of any of the crew suffering health problems during the flight involved in the accident.

3.1.3 History of the flight

- The crew received clearance to take off from runway 07 after a request to Grenchen aerodrome control (tower).
- The aircraft left the "white alpha" stand at 08:48 LT.
- The de-icing system was activated from the time the aircraft left the stand until executing the climb check.
- Due to the low visibility, a runway inspection was initiated by the air traffic control officer (ATCO).
- At 08:51 LT the crew received clearance to line up on runway 07.
- The commander taxied the aircraft onto runway 07 and initially turned to the west, in order to have the maximum runway length available for the subsequent take-off (backtrack).
- At 08:53:43 LT the crew of HB-VOV received take-off clearance: *"Hotel Oscar Victor, wind zero six zero degrees six knots, runway zero seven, cleared for take-off*".
- The crew carried out a standing take-off.
- During the take-off roll the crew noticed a slower acceleration than usual.
- HB-VOV reached a speed of 80 kt before taxiway ECHO 1 (cf. Annex 1).
- On attaining rotation speed (V_R) the crew was initially unable to lift the aircraft's nose due to the pitch down moment and rotate the aircraft.
- On overshooting the end of runway 07, the right main landing gear of HB-VOV struck an end-of-runway light.
- HB-VOV rolled onto the adjacent meadow and completed a rolling distance of more than 100 metres before it finally lifted off.
- During the climb, the crew realised that the parking brake was still set.
- The crew retracted the gear, but the red warning light did not go out.

- The crew then extended the gear again and the landing gear indicators indicated green again.
- The crew subsequently decided to make an alternate landing at Zurich airport.
- Without declaring an emergency and refusing higher landing priority, the crew made an approach on runway 14 and after an uneventful landing taxied directly to the stand on the apron near the general aviation centre (GAC).
- On the aircraft, structural damage was found in the area of the nose gear and main gear, as well as on both rear wing spars. Also, a certain asymmetry was determined in relation to the dimensions of the aircraft.

3.1.4 General conditions

- At the time of the accident, fog prevailed, with low visibility of approximately 300 metres.
- The TORA cited in the Swiss aeronautical information publication (AIP) for runway 07 is 980 m.
- The take-off roll calculation carried out using the flight management system (FMS) resulted in take-off field length of 856 metres.

3.2 Causes

The accident is attributable to a collision with obstacles beyond the end of the runway, because the aircraft did not achieve the expected acceleration during the take-off roll and because the take-off roll was nevertheless continued.

The following causal factors were identified:

- reduced acceleration of the aircraft during take-off because of the set parking brake.
- the missing decision of the crew to respond to the reduced acceleration by aborting the take-off.

The fact that the aircraft had no warning device to indicate a set parking brake when the take-off roll is initiated contributed to the accident.

4 Safety recommendations and measures taken since the accident

According to the provisions of Annex 13 of the ICAO, all safety recommendations listed in this report are intended for the supervisory authority of the competent state, which has to decide on the extent to which these recommendations are to be implemented. Nonetheless, any agency, establishment or individual is invited to strive to improve aviation safety in the spirit of the safety recommendations pronounced.

In the Ordinance on the Investigation of Aircraft Accidents and Serious Incidents (OIAASI), the Swiss legislation provides for the following regulation regarding implementation:

"Art. 32 Safety recommendations

[1] DETEC, on the basis of the safety recommendations in the SAIB reports and in the foreign reports, addresses implementation orders or recommendations to the FOCA.

[2] The FOCA informs DETEC periodically about the implementation of the orders or recommendations pronounced.

[3] DETEC informs the SAIB at least twice a year on the state of implementation by the FOCA."

4.1 Safety recommendations

4.1.1 Safety deficit

On 16 February 2011 a Citation C525 overshot the end of the runway and collided with obstacles during its take-off roll on runway 07 at Grenchen regional airport (LSZG). The accident is attributable to the fact that the expected acceleration during the take-off roll was not achieved because the parking brake was set. The investigation identified the absence of a warning device indicating a set parking brake on initiation of the take-off roll as a contributory factor.

The manufacturer of the aircraft stated that to its knowledge in the years from 1997 to 2011 a total of eleven incidents had occurred involving take-offs with the parking brake set.

4.1.2 Safety recommendation No. 455

"Das Bundesamt für Zivilluftfahrt (BAZL) bzw. die Europäische Agentur für Flugsicherheit (EASA) sollten zusammen mit der Zulassungsbehörde der Mustergruppe Cessna C525 eine technische Lösung entwickeln, welche die Besatzung beim Einleiten des Startlaufs mit gesetzter Festellbremse warnt."

[The Federal Office of Civil Aviation (FOCA) and the European Aviation Safety Agency respectively should develop a technical solution together with the licensing authority for the Cessna C525 type, which warns the crew when the take-off roll is initiated with the parking brake set].

4.2 Measures taken since the accident

The Federal Office of Civil Aviation (FOCA) has prescribed as accompanying measures a minimum visibility of 400 m for small aerodromes with standard instrument departures (SID).

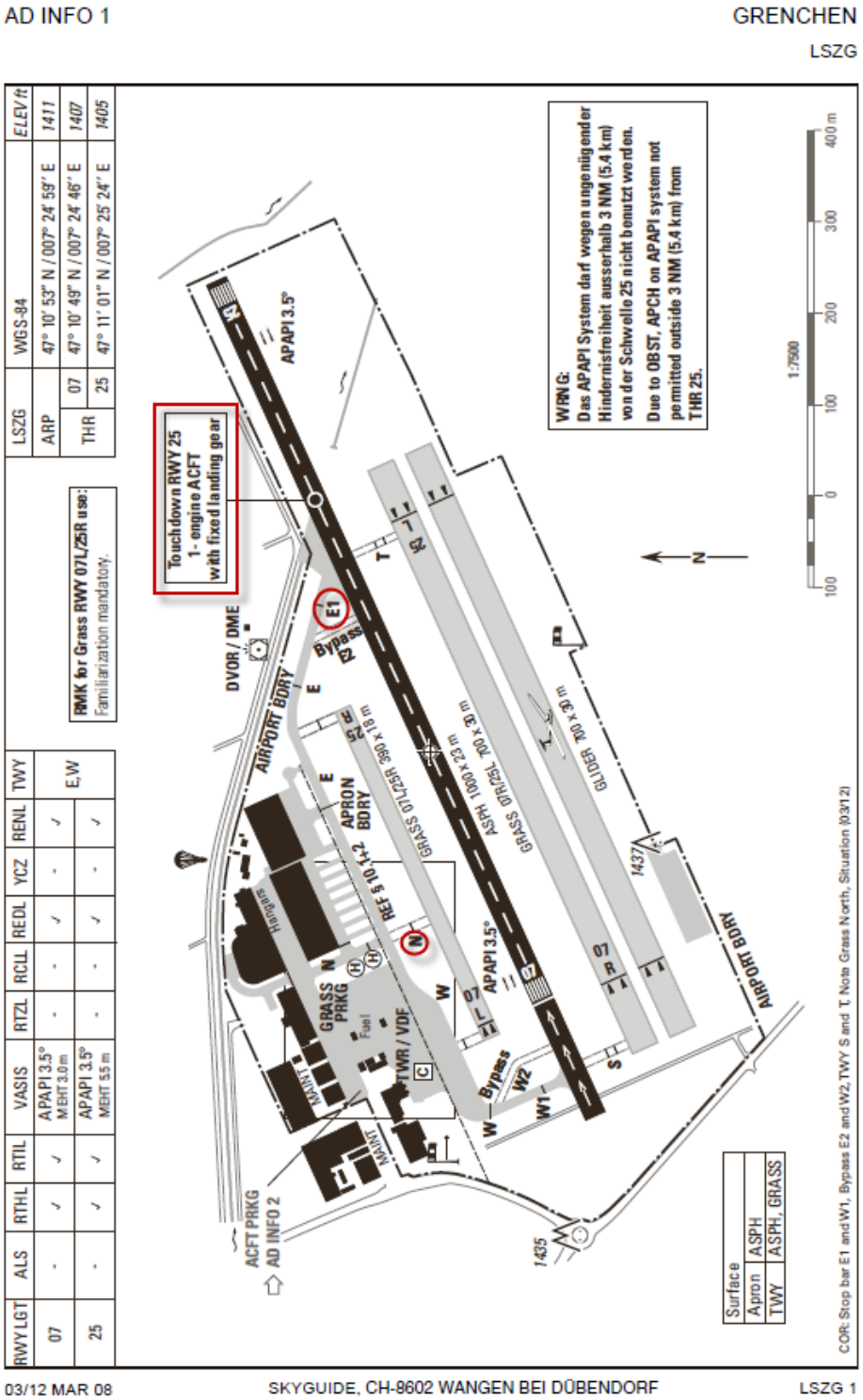
Payerne, 15 April 2013 Swiss Accident Investigation Board

This final report was approved by the management of the Swiss Accident Investigation Board SAIB (Art. 3 para. 4g of the Ordinance on the Organisation of the Swiss Accident Investigation Board of 23 March 2011).

Berne, 25 April 2013

Annexes

Annex 1: AD INFO 1 Chart of Grenchen regional airport (LSZG) from the VFR Manual



The minimum visibility for a take-off on runway 07 for category B aircraft specified in the Swiss Aeronautical Information Publication (AIP) is 300 m. The available runway length is 980 m.